

Title: Experimental Investigation of Charging Properties of Interstellar Type Silica Dust Grains by Secondary Electron Emissions

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The dust charging by electron impact is an important dust charging processes in astrophysical and planetary environments. Incident low energy electrons are reflected or stick to the grains charging the dust grains negatively. At sufficiently high energies electrons penetrate the grains, leading to excitation and emission of electrons referred to as secondary electron emission (SEE). Available classical theoretical models for calculations of SEE yields are generally applicable for neutral, planar, or bulk surfaces. These models, however, are not valid for calculations of the electron impact charging properties of electrostatically charged micron/submicron-size dust grains in astrophysical environments. Rigorous quantum mechanical models are not yet available, and the SEE yields have to be determined experimentally for development of more accurate models for charging of individual dust grains.

At the present time, very limited experimental data are available for charging of individual micron-size dust grains, particularly for low energy electron impact. The experimental results on individual, positively charged, micron-size lunar dust grains levitated carried out by us in a unique facility at NASA-MSFC, based on an electrodynamic balance, indicate that the SEE by electron impact is a complex process. The electron impact may lead to charging or discharging of dust grains depending upon the grain size, surface potential, electron energy, electron flux, grain composition, and configuration (Abbas et al, 2010, 2012).

In this paper, we discuss SEE charging properties of individual micron-size silica microspheres that are believed to be analogs of a class of interstellar dust grains. The measurements indicate charging of the 0.2 μ m silica particles when exposed to 25 eV electron beams and discharging when exposed to higher energy electron beams. Relatively large size silica particles (5.2-6.82 μ m) generally discharge to lower equilibrium potentials at both electron energies. These measurements conducted on silica microspheres are qualitatively similar in nature to our previous SEE measurements on lunar Apollo missions dust samples.